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Final Record of Decision
for Operable Unit 4
Schofield Army Barracks
Island of Oahu, Hawaii

Prepared for

U.S. Army Environmental Center
Installation Restoration Division

HLA Project No. 28339 14.03.00
Contract DAAA15-91-D-0013
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THIS DOCUMENT IS INTENDED TO COMPLY WITH THE NATIONAL ENVIRONMENTAL POLICY OF 1969.

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Total Environmental Program Support

Final Record of Decision for Operable Unit 4
Schofield Army Barracks, Island of Oahu, Hawaii

July 12, 1996
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1.0 DECLARATION

This Final Record of Decision (ROD) for Operable Unit (OU)4 has been prepared by Harding Lawson Associates(HLA) for the U.S. Army Environmental Center (USAEC) under Delivery Order No.DA03 of the Total Environmental Program Support (TEPS) Contract DAAA15-91-D-0013. This report documents the response action plan for OU 4 at Schofield Army Barracks (Schofield Barracks), Island of Oahu, Hawaii.

1.1 Site Name and Location

Schofield Barracks is located in the north-central plateau of the Island of Oahu in the State of Hawaii (Figure 1.1). The Schofield Barracks installation is approximately 22 miles northwest of the City of Honolulu. The closest municipality is Wahiawa, which is immediately north of Schofield Barracks. The installation is divided into two sections, the East Range and the Main Post (Figure 1.2), encompassing an approximate total area of 27.7 square miles. Wheeler Army Airfield lies between and to the south of the two Schofield Barracks sections.

The Schofield Barracks OU 4 consists of the Former Schofield Barracks Landfill (Former Landfill) on the Main Post of Schofield Barracks (Figure 1.3).

1.2 Statement of Basis and Purpose

This decision document (ROD) presents a response action for OU 4, the Former Landfill. This action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This ROD explains the basis for selecting the response action for OU 4. Information supporting the selected response action is contained in the Administrative Record for Schofield Barracks. The U.S. Environmental Protection Agency (EPA) and the State of Hawaii concur with the selected response action (remedy).

1.3 Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare, or the environment.

1.4 Description of the Selected Remedy

This OU is one OUs for the site. The function of OU 4 is to address the Former Landfill. The remedy addresses the Former Landfill as a potential source of groundwater contamination and reduces the potential risks associated with exposure to the contaminated landfill contents. OU 2 addresses the basewide groundwater contamination.

The following are major components of the selected remedy:

- Regrade existing landfill cover to generally match the 1983 engineered drainage grade
- Remove existing Guinea grass and revegetate with another type of grass that is more appropriate for a landfill cover
- Perform long-term maintenance of the landfill cover
- Maintain existing landfill gas venting
- Install additional gas monitoring points at the perimeter of the landfill
- Implement institutional controls (groundwater monitoring, five-year site review, land-use restrictions and site security)

1.5 Declaration Statement

The selected alternative is protective of human health and the environment, complies with federal and State of Hawaii requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This action is a permanent solution to the maximum extent practicable or necessary for OU 4 and is consistent with the EPA's Presumptive Remedy for CERCLA municipal landfills (EPA, 1993a). Because this action will result in hazardous substances (landfill contents) remaining onsite exceeding acceptable health-based levels, a review will be conducted within five years of commencement of the response action to ensure that the remedy continues to provide adequate protection of human health and the environment.

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2.0 DECISION SUMMARY

This section provides an overview of the site-specific factors and analyses that led to the selection of the preferred alternative. This overview includes a general site description, site history, enforcement and regulatory history, highlights of community participation, scope and role of OU 4, site characteristics, summary of site risks, and documentation of significant changes to these elements. Much of the information presented in this section was derived from previous investigations performed by the U.S. Department of the Army (Army), its contractors, and the EPA and has been previously presented in more detail in the Preliminary Assessment/Site Investigation (PA/SI) Report (HLA, 1992a),Remedial Investigation/Feasibility Study (RI/FS) Work Plan RA, 1992b), Final OU 4 Phase I Sampling and Analysis Plan (SAP) (HLA, 1993), Final OU 4 Phase II SAP (HLA, 1995a), and the Final Feasibility Study for Operable Unit 4 (HIA, 1995c).

2.1 Schofield Barracks Site Location and Description

Schofield Barracks is located in central Oahu (Figure 1.1) within the physiographic province known as the Schofield Plateau. Ground surface elevations range from approximately 700 feet (National Geodetic Vertical Datum of 1929 [NGVD]) near the central portion of Schofield Barracks to approximately 4,000 feet (NGVD) near the western boundary of the Main Post in the Waianae Mountain Range. The drainage divide of the Schofield Plateau runs roughly east-west through the center of the Main Post. North of this divide, watercourses flow to the north and discharge into Kaiaka Bay at the town of Haleiwa. South of this divide, watercourses flow south and discharge into the West Loch of Pearl Harbor. Narrow gulches dissect the plateau where streams have eroded the land surface.

The relativelv flat Schofield Plateau was formed as basaltic lava flowed from the adjacent Koolau and Waianae volcanoes to the east and west, respectively. The upper 100 to 200 feet of the basaltic bedrock within the Schofield Plateau is weathered saprolite. The saprolite consists of soil (primarily fine-grained materials including, silt and clay) formed by in situ decomposition of the basaltic bedrock. The saprolite is underlain by relatively unweathered basaltic bedrock consisting of interbedded pahoehoe and a'a lava flows. The lava flows are highly fractured with cinder and clinker zones.

Three types Of groundwater systems have been identified in central Oahu: (1) the Schofield High-level Water Body, (2) basal groundwater, and (3) dike-impounded groundwater (Figures 2.1 and 2.2). The Schofield High-level Water Body is located beneath the Schofield Plateau, and subsequently, the site. This water body is bound to the east and west by dike-impounded groundwater and to the north and south by basal groundwater. Lower permeability rocks (possibly volcanic dikes and/or buried ridges) structurally separate these groundwater systems from one another. The Schofield high-level aquifer has a high transmissivity and hydraulic conductivity. The depth to groundwater at the site is approximately 600 feet below ground surface (bgs) (approximately 270 feet above mean sea level [MSL]).

The climate at Schofield Barracks, which is south of the Tropic of Cancer at approximately 21 degrees north latitude, is characterized by moderate temperatures that remain relatively constant throughout the year. The average annual rainfall in the vicinity of Schofield Barracks is approximately 1.2 meters (Giambelluca and others, 1986), more than half of which occurs during the rainy season from November through February. Trade winds have an average speed of 12 knots and prevail from the northeast or east approximately 70 percent of the time.

Because of the relatively large amounts of undeveloped land, combined with a relatively large amount of vertical relief, Schofield Barracks is host to diverse and abundant flora and fauna. Undisturbed natural vegetation at Schofield Barracks is found primarily in the steep gulches on the east and west sides. These gulches support birds and other fauna and blocks of forestry plantings and dense shrubbery growth.

2.2 Schofield Barracks Installation Operational History

Schofield Barracks was established in 1908 as a base for the Army's mobile defense of Pearl Harbor and the Island of 0ahu. It served as a major support facility during World War II (WWII) temporarily housing more than one million troops. It also served as a support and training facility during the Korean and Vietnam conflicts. Since the Vietnam conflict, it has served primarily as a training facility.

Schofield Barracks is the Army?s largest installation outside of the continental United States. It currently serves as the home of the 25th Infantry Division (Light), whose mission is to be prepared to respond to war at a moment's notice. Installation facilities include a medical facility, community and housing support facilities, and transportation and repair facilities.

2.3 Enforcement and Regulatory History

Trichloroethene (TCE), a commonly used cleaning solvent, was detected in the Schofield Barracks water-supply wells in 1985. The source of the TCE contamination could not be identified. In September 1986, the Army installed air-stripping treatment units to remove TCE from the Schofield Barracks domestic water supply. In 1987, the EPA established a Maximum Contaminant Level (MCL) for TCE of 5 parts per billion in drinking water. TCE has not been detected in Schofield Barracks' treated groundwater at concentrations greater than this EPA-established limit.

As a result of the detection of TCE in the Schofield Barracks water-supply well Schofield Barracks was placed on the National Priorities List (NPL) in August 1991. The NPL was developed by EPA to identify sites that may present a risk to public health or the environment.

After Schofield Barracks was placed on the NPL, a Federal Facility Agreement (FFA) was negotiated among the EPA, the State of Hawaii, and the Army under CERCLA, Section 120. The FFA was signed by the Army on September 23, 1991, and by the EPA on September 27, 1991. Signature by the State of Hawaii is still pending. The FFA identified Schofield Barracks as being under the jurisdiction, custody, or control of the U.S. Department of Defense (DOD) and subject to the Defense Environmental Restoration Program (DERP).

2.4 Operable Unit 4 Site Selection History

As a part of the FFA, the Army and regulatory agencies agreed to divide the program into subunits called OUs to address potential areas of contamination at Schofield Barracks in an organized manner. This ROD addresses OU 4, which was established to investigate adverse impacts on groundwater, surface water, soil, or air caused by the Former Landfill.

During 1991, the Army began to investigate potential contaminant sources at Schofield Barracks through implementation of a PA/SI as required by the FFA. The objective of the PA was to identify possible onpost and offpost groundwater contamination sources both at Schofield Barracks and the surrounding study area. The PA consisted of the following three activities designed to collect additional information regarding Schofield Barracks and nearby offpost communities:

- Conduct an onpost records search of 10 onpost sites (including the Former Landfill) identified in the FFA (EPA and others, 1991).
- Survey and sample existing water-supply wells in the Schofield High-level Water Body.
- Conduct an industrial activity survey of communities in the study area to identify potential offpost TCE sources.

The objective of the SI was to collect field data to assess potential sources of contamination at the Former Laundry, the East Range Disposal Area, and the Former Landfill.

Results of the records search, industrial activity survey, well survey, and sampling were discussed in detail in the PA/SI Report (HLA, 1992a). Given the results of the PA/SI, an additional assessment was recommended. An additional assessment was conducted as a part of the Phase I RI for the Former Landfill. The results of the Phase I RI were presented in the Final Phase II RI Sampling and Analysis Plan (OU 4 Phase II SAP) (BIA, 1995a). The Final Phase II RI Sampling and Analysis Plan recommended additional assessment work that included surface-water resampling, soil-gas sampling, analysis of landfill cap and slope integrity, and well installation and sampling. As part of the Phase I and II RL, monitoring wells in the vicinity of the Former Landfill were installed to obtain additional information regarding groundwater flow and to collect groundwater samples from the Schofield High-Level Water Body near the Former Landfill. During Phase I and II Remedial Investigations, TCE was detected in subsurface-soil samples, leachate samples, and groundwater samples, indicating that the Former Landfill is a likely source of volatile organic compounds (VOCs) to groundwater beneath the landfill.

2.5 Operable Unit 4 Site Description

A description of past disposal practices, past landfill operations, and potential sources of contamination at OU 4 is provided below.

2.5.1 Past Disposal Practices

The Former Landfill was an open burn dump from approximately 1942 until 1967, when it was converted to a sanitary landfill in response to provisions of the Clean Air Act (Ecology and Environment, Inc., 1981; Kennedy Engineers, 1980b). The Former Landfill was used to dispose of a wide variety of solid wastes from various military installations, of which the major contributors were Schofield Barracks, Wheeler Air Force Base (currently Wheeler Army Airfield), and the Wahiawa Radio Station (U.S. Army Support Command, Hawaii [USASCH], 1983; Kennedy Engineers, 1980b). Most of the waste deposited in the landfill was domestic refuse from the surrounding base housing (Ecology and Environment, Inc., 1981); however, wastes were also disposed from various industrial operations (e.g., vehicle and equipment maintenance and construction). Tripler Army Medical Center (TAMC) reportedly contributed medical wastes including pathogenic, infectious, and pharmaceutical (expired and unusable drugs) wastes (Ecology and Environment, Inc., 1981; Kennedy Engineers, Inc., 1980b).

Other materials reportedly disposed in the Former Landfill were organic solvents, sewage sludge, asbestos, pesticide containers, unusable paints, metallic debris, vegetation, and tree stumps (Environmental Science and Engineering (ESE), 1984). Hazardous materials, including live munitions, acids, and solvents, were also reported to have been dumped in the landfill (Asquith, 1982; Kennedy Engineers, 1980b). HLA personnel interviewed Mr. Steve Kim, Directorate of Health Services, TAMC, an December 6, 1991. Mr. Kim reported that a mortar round and a rocket casing had been excavated from the landfill in the past. In addition. Ecology and Environment, Inc., (1981) reported that 90-millimeter (mm) shells exploded onsite when they were struck by a landfill tractor. The EPA Field Investigation Team (FTT report (Ecology and Environment, Inc., 1981) cited two explosions of drummed material labeled methyl ethyl ketone, and indicated that an area may exist where 20- to 25-gallon glass containers containing concentrated sulfuric acid are buried. No records were available concerning the types, amounts, or volumes of wastes disposed at the Former Landfill, but the rate has been estimated at 100 tons per day (Kennedy Engineers, 1950b).

Although the Former Landfill was not a permitted hazardous waste disposal facility, no provisions were made to exclude hazardous waste (Ecology and Environment Inc., 1981). Hazardous wastes generated by military installations on Oahu before 1980 were inventoried and found to include wastes being transported to and disposed in the Former Landfill (Kennedy Engineers, 1980b). Apparently, there was "haphazard disposal of material" that appeared to "increase by magnitudes before a visit by the Inspector General" (Ecology and Environment, Inc., 1981). Loads were not regularly inspected, and a Former Landfill operator indicated that "anything" could have been dumped at the site (Kennedy Engineers, 1980b).

In 1980, a State of Hawaii Department of Health (DOH) representative, issued a Solid Waste Management Permit (operating permit) for the Former Landfill. The permit called for closure an or before December 31, 1981, because the DOH and the City and County of Honolulu Board of Water Supply (BWS) were concerned about potential groundwater contamination to the Schofield High-level Water Body. In September 1983, the Former Landfill was closed. The closure plan did not include provisions for installations of monitoring wells or a leachate collection system (Kennedy Engineers, 1980a).

2.5.2 Related Landfill Operations

Before 1967, when the Former Landfill was operated as an open burn-type dump, it consisted of two pits into which solid waste was dumped and burned. Apparently, the remains were then pushed into adjoining Kaukonahua Gulch. Another disposal area along the gulch leading to the Kaukonahua. Stream bed was used mainly for demolition and construction debris. Bulk refuse was dumped over the edge of the landfill; the results were underground fires and an open refuse face. When the Former Landfill was designated a sanitary landfill in 1967, operations were converted to the trench method; wastes were spread in excavated trenches, compacted in layers, and covered with soil on a daily basis. In addition to the burial of domestic refuse in excavated trenches, demolition and construction debris was dumped into the small valley located in the eastern midsection of the landfill. Trenching operations appeared to have been unplanned and poorly organized, and cover it over soil tended to be applied only when the trench was completely filled (Kennedy Engineers, 1980b).

A junked car repository, covering approximately 1 acre, was located in the center of the Former Landfill (Figure 2.3). In 1977, the vehicles were sold and removed (Kennedy Engineers, 1980b).

A sewage treatment plant was operated in the northern section of the Former Landfill (Figure 2.3). A 1977 topographical survey of the landfill depicts four circular areas, concrete pipes, and a sludge tank in the area of the plant (R.M. Towill Corporation [RMT], 1977). An Environmental Impact Assessment (EIA), describing demolition and abandonment of the sewage treatment plant (U.S. Army Pacific Environmental Health Engineering Agency [USAPEHEA), 1977), called for in-place abandonment of the pumphouse, concrete filter bed, septic tank, settling tank, three sludge beds, chlorinator, and valve sheds. The EIA stated that the abandoned tanks were to be filled with solid waste and covered with compacted layers of soil. The plant was eventually abandoned, and in 1979, the remaining sections were demolished and the site was covered. Reportedly, some concrete tanks were not completely demolished, but were filled with rubble before they were covered (Kennedy Engineers, 1980a). In 1977, most of the landfill had been used for trenches, so the life of the landfill was extended in the northern and eastern areas of the landfill by adding an 8-foot lift. Figure 2.4 illustrates the approximate locations of the northern and eastern area fill.

In 1980, an area-fill operation was located near the center of the landfill beside the drainage ditch (Figure 2.4) that had been placed over a previously trenched area. This unlined drainage ditch separated the southern and eastern portions from the northern ridge. A 6-foot-high berm was constructed along the drainage ditch to form this fill area. The placement of fill progressed in a northerly direction.

Hospital, drug, and pharmaceutical waste was dumped in the area of general waste and bulldozed with the other refuse (Kennedy Engineers, 1980b). Mr. Kim verified that infectious waste from TAMC was dumped in the landfill before 1980 and that disposal had been allowed by state permit and the Surgeon General. The state later withdrew its approval (HLA, 1992b). Infectious waste disposal was banned by the DOH as of December 31, 1980 (Kennedy Engineers, 1980b). Digested wastewater sludge was spread over the landfill surface in the eastern ridge bordering Waikoloa Gulch before November 1982 and prior to placement of a soil cap (Ecology and Environment, Inc., 1981). Although laboratory analyses confirmed the presence of heavy metals in the sludge, extraction procedure toxicity tests (EP TOX) were not performed (Ecology and Environment, Inc., 1981).

Landfill operations ceased on December 31, 1981, and closure occurred in two phases. The landfill surface was graded and covered with a layer of compacted soil 2 to 2-1/2 feet thick. Closure was initiated in August 1982 and was 95 percent complete by the end of 1983. Reportedly, the landfill was to be periodically monitored and inspected for any deficiencies, and corrective activities were to be initiated, if necessary (USASCH, 1983). However, there is no record of monitoring and inspections being performed. As a result, landfill subsidence has resulted in numerous cracks and deterioration of the landfill cap.

2.6 Highlights of Community Participation

In an effort to involve the public, the Army has undertaken several public and community awareness efforts, including issuance of employee bulletins and post newspaper articles for Schofield Barracks employees, media interviews, news releases, and meetings with local officials and neighborhood boards for offpost residents. In addition, the Army has held public meetings, issued fact sheets, and established an Army contact for the public at Schofield Barracks' Public Affairs Office. Copies of work plans, technical reports, fact sheets, and other materials related to the project are available for public review at the local repositories:

Mililani Public Library
95-450 Makaimoimo Street
Mililani, Hawaii 96789

Wahiawa Public Library
820 California Avenue
Wahiawa, Hawaii 96786

US. Army Garrison, Hawaii
Directorate of Public Works
Building 105
Wheeler Army Airfield, Hawaii 96857-5000

State of Hawaii Department of Health
Environmental Quality Control Office
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

On April 11, 1996, the Army presented the Proposed Plan for OU 4 at Schofield Barracks to the public for review and comment. The Proposed Plan summarizes information collected during the OU 4 PA/SI and RI and other documents in the Administrative Record for the Schofield Barracks RI/FS that are available at the above local repositories. In addition, the proposed plan summarizes the alternatives contained in the FS and outlines the selected remedy.

Comments regarding the Proposed Plan were accepted during a 30-day public review and comment period that began on April 11, 1996. A public meeting was held on May 1, 1996, at 7:00 p.m. in the Hale Koa at Wahiawa District Park, Wahiawa, Hawaii. At that time, the public had the opportunity to discuss the proposed plan with the Army, EPA, and the Hawaii DOH. In addition, written comments were accepted during the public comment period. However, no written comments were received during the public comment period. The public comment period, as discussed above, is a continuation of the Army's commitment to community involvement in the Schofield Barracks Installation Restoration Program (IRP) and is required by CERCLA.

2.7 Scope and Role of Operable Unit

The role of OU 4 in the overall NPL program for Schofield Barracks is to identify and eliminate hazardous wastes associated with the Former landfill that pose a threat to human health and the environment OU 1 addresses other onpost sites that were suspected to be sources of TCE contamination. Basewide groundwater contaminated with TCE is addressed under OU 2. OU 3 addresses other sites that are suspected contamination sources at Schofield Barracks not covered by other OUs.

The objectives of the OU 4 program are to:

- Investigate the site to identify adverse impacts on groundwater surface water, soil, or air caused by the Former Landfill
- Evaluate the risks to human and ecological receptors based on impacts to these media
- Evaluate and select appropriate containment and monitoring alternatives

A PA/SI and RI was performed at OU 4. The ST and RI activities conducted for OU 4 included soil-gas sampling and analysis, surface-water sampling, surface-soil sampling, subsurface-soil sampling, groundwater sampling, and lysimeter sampling. Because TCE was detected in subsurface-soil samples, groundwater samples, and lysimeter samples, it is likely that the Former Landfill is contributing contaminants to the groundwater.

2.8 Site Characterization

To assess site characteristics soil-gas, surface-soil, subsurface-soil, surface-water and sediment, landfill gas, pore water, groundwater, and ambient air sampling were performed as a part of the RI/FS activities. A summary of chemicals of potential concern (COPCs) for OU 4 is presented in Table 2.1.

Landfill contents were not characterized because EPA's Presumptive Remedy for CERCLA Municipal Landfill Sites guidance document (EPA, 1993a) indicates that characterization of a landfill's contents is not necessary or appropriate for selecting a response action for CERCLA municipal landfill sites. A summary of the sampling results for each of the above media is provided in the following paragraphs.

2.8.1 Soil Gas

Shallow soil-gas surveys were performed at the Former Landfill as a part of the SI and the Phase I and Phase II RI/FS field programs. Several VOCs were detected in the shallow soil-gas samples that were obtained from approximately 10 feet bgs. The most prevalent VOCs were TCE, trichloroethane (TCA), vinyl chloride (VC), and total volatile hydrocarbons (TVH). The TVH are believed to be primarily methane. Figure 2.5 shows the location of TCE detections from the OU 4 Phase I RI. VOC detections were bounded by nondetections, providing an approximation of the lateral extent of contamination in each area. Low concentrations of TCE were detected in a large portion of the central area of the landfill as well as in the northern, northeastern, and southern portions of the landfill. The highest concentrations of TCE were detected in the northeastern portion of the landfill. Low concentrations of VC were detected in small areas in the central, northern, and northeastern portions of the landfill, but the lateral extent of these VC detections is very limited. Low concentrations of TCA were detected in some areas of the northern and central portions of the landfill and along the western boundary as shown in the OU 4 Phase II SAP (HLA, 1995a). Low levels of TVH were detected across the landfill area.

Deep soil-gas samples were collected at several depths from soil borings installed during the Phase I RI. Other than TVH and benzene, ethylbenzene, toluene, and total xylenes (BTEX) compounds, the only VOCs detected in the deep soil-gas samples were methylene chloride, tetrachloroethene (PCE), and TCE. Low concentrations of methylene chloride were detected in three of the borings at 50 to 100 feet bgs. PCE was detected at 100 feet bgs in a boring in the southeastern part of the landfill, and TCE was detected at two depths (50 and 100 feet bgs) in a boring in the northeastern portion of the landfill in the area where the highest concentrations of TCE were detected in the shallow soil gas. TCE was also detected in concentrations up to 34 parts per million (ppm) in gas samples collected from piezometers (near Boring 8) in the northeastern portion of the landfill during the in situ air permeability test. TCE detections in the piezometers extended to depths of 200 feet bgs.

These results indicate that TCE is the most prevalent chemical detected in both the shallow and deep soil gas. The highest concentrations of TCE in soil gas occurred in the vicinity of Boring 8 in the northeastern portion of the landfill (Figure 2.5).

2.8.2 Surface Soil

Surface-soil samples were collected as a part of the Phase I RI. Only very low concentrations of three organic compounds and a few metals were detected in the surface-soil samples. The organic compounds included one explosive compound, one pesticide compound, and one polychlorinated biphenyl (PCB) compound. The detections of both metals and organic compounds were below EPA Region IX Preliminary Remediation Goals (PRGs). These low levels of surface-soil contamination indicate that surface soil in the vicinity of the Former Landfill has not been impacted by contaminants contained within the landfill at concentrations above EPA risk-based levels.

2.8.3 Subsurface Soil

As a part of the Phase I RI eight borings distributed throughout the landfill area were drilled through the landfill mass into the subsurface soil underlying the buried refuse (Figure 2.6). Samples were collected from the subsurface soil beneath the refuse. The only organic compounds detected other than very low concentrations of suspected laboratory contaminants, were one very low concentration of nitrobenzene from Boring 1 (70.8 feet bgs) in the northwestern portion of the landfill, and a low concentration of PCE in one sample at 55.5 feet bgs and a low concentration of TCE and 1,2-dichloroethene (1,2-DCE) in a sample from 70.3 feet bgs, from Boring 8 in the northeastern portion of the landfill. All detections of organic compounds were below the EPA Region IX PRGs for the respective chemicals. However, concentrations of TCE as high as 3,000 micrograms per liter (?g/L) were detected in lysimeter port-water samples from the same boring in the northeastern portion of the landfill where TCE was detected at a low concentration of at a low concentration of 0.068 ?g/l in a subsurface-soil sample at 70.3 feet bgs.

Several metals were detected in soil samples collected from each of the borings. The metals detections were relatively uniform across the landfill area and were generally below the corresponding EPA Region IX PRGs with the exception of aluminum and beryllium. Aluminum and beryllium detections that exceeded PRGs were at similar concentrations to those found in background samples collected as part of the OU 1 RI (HLA, 1995b). For example, concentrations of aluminum detected in soil samples from the landfill range from 44,200 g/kg to 129,000 g/kg and background soil sample aluminum concentrations range from nondetect to 125,000 ?g/kg and concentrations of beryllium detected in soil samples from the landfill range from nondetect to 3.51 g/kg and background soil sample beryllium concentrations range from nondetect to 2.05 g/kg.

Detections of organic compounds in subsurface soil were very limited and did not indicate a pattern of contamination. However, the TCE detection in Boring 8 did correlate With TCE contamination in the shallow and deep soil-gas and pore-water samples from this area of the landfill.

2.8.4 Surface Water and Sediment

The only surface-water bodies in the vicinity of the landfill are Kaukonahoa Stream and its tributaries north of the landfill. During the SI and Phase I and II RI/FS field investigations, surface-water and sediment samples were collected from several locations along Kaukonahuia Stream and its tributaries. Very low concentrations of a few organic compounds were detected in surface-water samples during each of the three rounds of sampling. These organic compounds consisted primarily of low levels of VOCs and semivolatile organic compounds (SVOCs) that are likely laboratory contaminants. Low concentrations of a few pesticides and explosive compounds were also detected in both surface water and sediment samples. The concentrations detected were below the EPA Region IX PRGs for the respective chemicals for each matrix. The detections did not appear to exhibit a trend or to be related to contamination within the body of the landfill. Further information regarding surface-water and sediment sampling results is provided in the PA/SI Report (HLA, 1992a), the OU 4 Phase II SAP (HLA, 1995a), and the OU 4 FS (HLA, 1995c).

2.8.5 Landfill Gas

Five landfill gas monitoring wells were installed during the Phase II RI/FS field program. Gas samples were collected from these wells and analyzed for VOCs for three monthly monitoring events. These results indicate the presence of numerous VOCs in the landfill gas in concentrations up to 2,200 parts per billion volume (ppbv). The highest concentrations of petroleum-related VOCs, such as benzene, were detected in a gas monitoring well (GMW-4) in the central portion of the landfill. The highest concentration of chlorobenzene, which was the VOC detected at the highest concentration, was also detected in this well. The highest concentration of chlorinated hydrocarbons were detected in GMW-1 in the northeastern part of the landfill near soil Boring (Lysimeter) 8 (Figure 2-6).

2.8.6 Leachate

Leachate was not found during the Phase I and Phase II RI/FS field program, indicating that leachate is not accumulating beneath the landfill in the areas investigated. Therefore, lysimeters were installed in the unsaturated subsurface soil below the landfill contents. Samples of pore water were collected from these lysimeters. The concentration of contaminants in the pore-Water samples provides an estimate of what the characteristics of leachate could be if it were to accumulate beneath the landfill. These pore-water samples indicated the presence of low concentrations, of several VOCs in pore water from all areas sampled. The only VOC compound present in concentrations above 100 ?g/l was TCE in Lysimeter 8 in the northeastern portion of the landfill (Figure 2.6). TCE was detected in samples from Lysimeter 8 in concentrations up to 3,000 ?g/l. The higher levels of contamination in the samples from Lysimeter 8 were consistent with detections of TCE in shallow and deep soil-gas and subsurface-soil samples from this area.

2.8.7 Groundwater

As a part of Phases I and II of the RI/FS field program, four groundwater monitoring wells were installed around the Former Landfill.

Three rounds of sampling data were collected for MW-4-1,MW-4-2/2A, MW-4-3, and MW-4-4. The groundwater sampling results of the three rounds for these four wells indicated that the groundwater beneath the landfill contain low levels of TCE, carbon tetrachloride (CCL4), carbon disulfide, and chloroform. The only VOCs detected above MCLs were TCE and CCL4, in MW-4-1, southeast of the landfill, TCE in MW-4-3 to the south-southeast and MW-4-4 to the north of the landfill (Figure 2.6). TCE was detected below the MCL (5?g/l) in MW-4-2/2A to the northwest of the landfill VOCs have not been detected in Well 3-3103-01, which is the nearest offsite well located approximately 1 mile to the northeast and believed to be downgradient of the Former Landfill. Low concentrations of a few pesticides were also detected in groundwater samples collected from those wells, but the pesticide detections were inconsistent and were below MCLS and EPA Region IX PRGs for tap water. On the basis of these results, VOCs from the Former Landfill appear to have impacted groundwater beneath and adjacent to the landfill; however, evidence of offsite migration of contaminants has not been detected in irrigation wells to the north.

2.8.8 Ambient Air

Upgradient and downgradient ambient air samples were collected and analyzed as a part of the Phase I RI. No organic compounds were detected in either the upgradient or downgradient ambient air samples at the time of sampling indicating that, under similar meteorological conditions, the ambient air in the vicinity of the Former Landfill has likely not been impacted by contaminants present in the landfill contents.

2.8.9 Summary of Site Characterization

The only media associated with the Former Landfill, other than landfill contents and landfill gas, that appear to have been impacted by contaminants within the landfill are soil gas, subsurface soil, and groundwater. Leachate was not observed; however, high concentrations of TCE were present in the pore-water samples from Lysimeter 8. Very low concentrations of a few organic compounds and some metals were detected in surface soil, surface water, and sediments; however, all of the chemicals detected were below their corresponding EPA Region IX PRGs or MCLs. There also did not appear to be any consistent pattern to these low-level detections.

Low concentrations of VOCs were detected in shallow and deep soil gas from several locations within the landfill area. Low concentrations of VOCs were also detected in subsurface-soil samples and pore-water samples. The only area of the landfill having concentrations of VOCs in each of these media was the northeastern portion of the landfill in the vicinity of Lysimeter/Boring 8. Therefore, this area of the landfill may contain elevated concentrations of TCE, which can be roughly estimated by the extent of the TCE detections in shallow soil gas (Figure 2.5). However, based on available data it is not possible to accurately define the extent and volume of the media impacted by elevated TCE concentrations.

2.9 Summary of Site Risks

A baseline risk assessment was prepared to evaluate the potential human and ecological risks posed by chemicals detected at OU 4. This baseline risk assessment is provided as Appendix I in the OU 4 is FS Report (HLA, 1995c). The data collected during the Phase I and Phase II RI were used as the primary source for analytical data for the human health risk assessment (HRA) and the ecological risk assessment (ERA). The media of interest for the risk assessment were surface soil, surface water, and sediment These are the only media for which a pathway of exposure exists for human or environmental receptors. Further information regarding the procedures for identifying media of interest, identification of COPCs, and risk estimation procedures are provided in the baseline risk assessment for OU 4 (HLA, 1995c). Risk from potential exposure to groundwater was evaluated under the scope of OU 2 which separately addressed installation-wide contaminated groundwater. Specific conclusions of that risk assessment are available in the ROD for OU 2 and sources referenced therein.

The analytical sampling data for surface soil, surface water, and sediment were screened in the HRA to select a list of site-related COPCs. Table 2.1 presents selected COPCs for each media type at OU 4. The maximum detected concentrations in soil and sediment were compared to the risk-based screening concentrations (RBSCs) for industrial land use prepared by EPA Region IX. If the maximum detected concentration did not exceed the RBSC, the chemical was not selected as a COPC and was not included in the risk assessment For inorganic chemicals detected in soil, an additional comparison was made to the 95 percent upper confidence limit for background concentrations presented in the Final OU 1 RI Report (HLA, 1995b). If the maximum detected concentration of an inorganic chemical did not exceed the background concentration, the chemical was not included in the risk assessment. For surface water, if the maximum concentration did not exceed the MCL, the chemical was not retained as a COPC. To be conservative, drinking water standards (MCLs) were used, although surface water on post is not used as a drinking water source. For chemicals exceeding the MCL, a further comparison was made to the EPA Region IX RBSC for tap water use. If the maximum detected concentration was below the EPA Region IX tap water RBSC, the chemical was not retained as a COPC. The HRA considered three potential future receptor populations: a remedial worker, a long-term recreational user, and military personnel involved in field maneuvers or field exercises. Each of these populations was evaluated for ingestion of and dermal contact with surface soil, surface water, and sediment No current human populations were identified at the site. Potential exposures were evaluated for both average case and reasonable maximum exposure (RME) scenarios. Different exposure and chemical intake assumptions were used to differentiate between the average and RME scenarios. Average and RME exposure point concentrations (EPCs) for COPCs in each media were estimated as the arithmetic mean and 95 percent upper confidence limit, respectively, as recommended by EPA.

Carcinogenic risks and noncarcinogenic health effects were characterized for each population by combining the estimated chemical intakes with the appropriate toxicity factors (i.e., carcinogenic slope factors and noncarcinogenic reference doses). Only chronic toxicity factors were used in the HRA. Oral toxicity factors were used to evaluate both oral and dermal exposures, with the exception of dermal exposure to carcinogenic polynuclear aromatic hydrocarbons (PAHs). In accordance with EPA guidance, potential risks from dermal exposure to carcinogenic PAHs were not included in the risk characterization. Because background concentrations for inorganics were available, risks were characterized as both total risks and incremental risks (i.e., the contribution of background concentration of inorganics has been subtracted from the total risk). Table 2.2 presents the RME total and incremental carcinogenic risks and noncarcinogenic hazard indices for each of the three potentially exposed populations. None of the estimated hazard indices exceeds 1.0, the EPA benchmark for concern for noncarcinogenic health effects. The maximum total carcinogenic risk (including background) is 1.58 x 10-6, which is at the lower limit of EPA's acceptable risk range (i.e., 10-4 to 10-6). None of the incremental risks (i.e., with background risks subtracted) exceeds the lower acceptable limit of 1 x 10-6.

In addition to the quantitative HRA, a qualitative ERA was also developed. Because of the physical characteristics of the site (e.g., buried waste in a capped landfill), opportunities for exposure of ecological receptors are very limited. No clearly distinguishable patterns of contamination were detected in either surface soil, surface water, or sediments in Kaukonahua Stream. Based on the limited number and low concentration of organics detected, the naturally occurring background concentrations of inorganics, and the limited opportunity for contact with surface water and/or sediments (due to the ephemeral nature of surface water at the site), no hazards to local plant and animal life were noted.

2.10 Description of Alternatives

This section identifies and describes the four alternatives that were developed based on EPA's Presumptive Remedy (EPA, 1993a). The action-specific applicable or relevant and appropriate requirements (ARARs) considered for these alternatives are summarized in Table 2.3. No chemical-specific ARARs were identified for the site because EPA's Presumptive, Remedy for CERCLA Municipal Landfill Sites guidance document (EPA, 1993a) indicates that chemical characterization of a landfill's contents is not necessary or appropriate for selecting a response action for CERCLA municipal landfill sites, and no location-specific ARARs were found to be relevant to the site. A detailed description of each alternative is provided below.

2.10.1 Alternative I - No Further Action/institutional Controls

Alternative I includes the following components:

- No Further Action
- Institutional Controls
  - Long-term groundwater monitoring using existing monitoring wells
  - Five-year site review
  - Access restriction and site security

These components of Alternative 1 are described below.

No Further Action

Under Alternative 1, no further action would be performed to reduce the mobility, toxicity, or volume of the contaminated media. The No Further Action alternative is required as part of the NCP and provides a baseline to compare other alternatives against. Because the landfill was capped with approximately a 3-foot-thick layer of low-permeability material in 1983, a component of this alternative is No Further Action.

Institutional Controls

Institutional controls such as groundwater monitoring, five-year site review, and access restriction and site security, are used to supplement engineering controls for short-and long-term management to prevent or limit exposure to hazardous substances. Although institutional controls do not reduce mobility, toxicity, or volume of contaminant , they will likely be necessary to maintain the integrity of any response action selected for OU 4 and may reduce the potential for, human exposure to contaminated landfill contents and contaminated groundwater beneath the landfill.

Groundwater Monitoring. Groundwater monitoring is included in Alternative 2 to monitor the effectiveness of the existing landfill cap with respect to preventing further groundwater contamination. Groundwater monitoring will also be addressed as part of the OU 2 FS to evaluate any impact of the landfill on downgradient groundwater quality.

For the purposes of the FS, the conceptual monitoring well network includes the following six existing monitoring wells, which are illustrated in Figure 2.7:

- MW-2-2

- MW-4-1 (3-3004-1)

- MW-4-2A

- MW-4-3 (3-3004-3)

- MW-4-4

- 3-3103-01

Monitoring Wells MW-4-1, MW-4-2A, MW-4-3, and MW-4-4 are wells that were installed during the RI specifically for the purpose of monitoring groundwater in the vicinity of the Former Landfill. Monitoring Well MW-4-2A provides monitoring of the groundwater immediately upgradient of the Former Landfill. Monitoring Wells MW-4-1, MW-4-3, and MW-4-4 monitor groundwater either downgradient or crossgradient of the Former Landfill. Monitoring Well MW-2-2, installed as part of the OU 2 RI, has been included to provide an additional monitoring point upgradient of the Former Landfill. As indicated by the conceptualized flow lines in Figure 2.7 two upgradient groundwater sources may impact the Former Landfill. These sources are (1) water recharging from the Koolau Mountain Range (which is monitored by MW-2-2) and (2) water recharging from the Waianae Mountain Range (which is monitored by MW-4-2A). Monitoring Well 3-3103-01 is an offsite irrigation well that has been included to provide monitoring of offsite groundwater downgradient of the Former Landfill.

Samples will be collected from these wells on a semiannual basis. The only analytes that have been detected above MCLs established by the EPA are VOCs (i.e., carbon tetrachloride and TCE). Therefore, groundwater samples will be analyzed for these three compounds on a semiannual basis. Samples will be analyzed for the VOCs presented in Table 2.4 on an annual basis to confirm that no is other VOCs have migrated to the groundwater system. Because VOCs generally migrate more quickly in the subsurface than other analytes, it will not be necessary to analyze the samples for the other analyte groups unless an increasing trend is observed in the detected VOC concentrations.

Water levels will be monitored in the wells included in this monitoring network on a semiannual basis in conjunction with collection of groundwater samples. These water-level measurements will be used to evaluate any changes in groundwater flow patterns in the vicinity of the Former Landfill.

Five-Year Site Review. In accordance with CERCLA, a site review will be conducted every five years until the PRGs for the groundwater under the landfill are achieved. Groundwater data for the previous five years for OU 4 will be evaluated and presented in a report to assess whether additional action is warranted.

Access Restrictions and Site Security. Access restrictions and site security are used to (1) limit human exposure to the landfill contents, (2) prevent trespassing, and (3) protect the integrity of the cap. The existing chain-link fence around the perimeter of the accessible portions of the landfill would be maintained as an access restriction. Signs that warn of potential health risks will be posted on the fence. The Former Landfill is part of a military installation that has a guard stationed at the entrances to monitor access to the installation 24 hours per day. These security measures will be maintained.

2.10.2 Alternative 2 - Maintenance of the Landfill Cover

Alternative 2 includes the institutional controls that were previously described as part of Alternative 1 with the following additional components:

- Regrade existing landfill cover to generally match the 1983 engineered drainage grade
- Perform long-term maintenance of the landfill cover
- Maintain existing passive landfill gas venting
- Install additional gas monitoring points at the perimeter of the landfill

These components of Alternative 2 are described below.

Regrade using Landfill Cover

Regrading the existing landfill cover involves backfilling and compacting areas on the cover where subsidence has occurred, primarily in the former trench locations, to match the previously engineered grade. Low-permeability borrow material will be transported from local sources and placed and compacted in areas where subsidence has occurred. The volume of borrow material required to fill the former trench areas to match existing grade was estimated using the results of the visual survey conducted as part of the Phase II RI. Based on the visual survey, it was estimated that the former trench areas have subsided approximately 2 feet on average. It is estimated that approximately 18,000 cubic yards of borrow material will be required to restore the former trench areas to existing grade.

The TerraModel* computer program (Plus III Software, Inc., Release 8.33) was used to estimate the additional volume of borrow material required to regrade the landfill cover to match the original, engineered grade. TerraModel* estimates cut/fill volumes by comparing topographic information. TerraModel* was used to compare the as-built drawings prepared for the cover in 1983 (Figure 2.8) to a survey map prepared for the cover in 1995. TerraModel* indicates that approximately 40,000 cubic yards of borrow material will be required to restore the existing grade.

Repairs to the sideslopes of the existing cover will be performed to cover the areas of exposed waste identified in Figure 2.9. Repairs to the sideslopes will be made by placing and compacting fill material on the sideslopes to cover any exposed areas. Heavy equipment traffic on the sideslopes (i.e., bulldozers) will be minimized to reduce the impact of construction activities on slope stability.

Areas of the cover that require revegetation will be hydroseeded using a readily available seed mixture, such as a mixture of Buffalo grass and annual rye, to minimize erosion. It is anticipated that the new vegetative cover will minimize erosion until the Guinea grass becomes re-established in the areas affected by construction activities. Erosion control matting will be used, as required, on the affected areas of sideslopes to minimize erosion until the vegetative layer is established.

Improvements will be made to the existing surface drainage illustrated in Figure 2.8 to repair existing erosion and prevent further erosion.

Long-term Maintenance of Landfill Cover

Long-term maintenance of the landfill cover will be conducted in accordance with the postclosure ARARs identified in Hawaii Administrative Rules (HAR) ?11-58.1-16. The postclosure requirements for a Municipal Solid Waste Landfill (MSWLF) require that the integrity and effectiveness of any final cover be maintained, including making repairs to the cover, as necessary, to correct the effects of settlement, subsidence, erosion, or other events and preventing run-on and runoff from eroding or otherwise damaging the final cover. The results of the long-term settlement tests indicate that approximately 3 to 6 inches of settlement may be expected during the first two years after the cap improvements are completed due to the additional cover material weight. Periodic maintenance may be required to repair damage to the cover caused by additional settling.

Long-term maintenance of the landfill cover may include the following:

- Inspecting the cover quarterly and after heavy rainfall events for evidence of damage due to erosion, settlement, slumping, drought, fire, pestilence, debris accumulation, animal burrows, or any other adverse conditions.

- Making repairs to the cover, as necessary to correct the effects of erosion, settlement, slumping,, drought, fire, pestilence, debris accumulation, or any other adverse condition.

- Mowing the existing Guinea grass quarterly prior to the quarterly cap inspections.

If damage to the cap is not noted in four consecutive quarterly inspections, the frequency of inspection and mowing of grass may be reduced to a semiannual basis.

Passive Landfill Gas-Venting

Passive landfill gas-venting is included as part of this alternative to provide a pathway for landfill gas to escape through the improved cover to relieve gas pressure in the landfill. The passive landfill gas-venting will consist of the five existing monitoring wells shown in Figure 2. 10, with minor modifications. Minor modifications include extending the existing pipes to ensure that the pipes extend 4.0 feet above the final surface after grading operations are completed. The existing pipe will be vented to the atmosphere. For protection of the existing landfill gas wells, a concrete collar will be placed around the existing pipes to approximately 24 inches above finish grade. These enhancements will provide structural protection of the landfill gas monitoring points and will keep rainfall out of the open pipe.

Perimeter Landfill Gas Monitoring

Landfill Gas (LFG) monitoring wells will be installed around the perimeter of the landfill to evaluate the subsurface migration of LFG. The LFG monitoring system will include the nine gas monitoring wells conceptually shown in Figure 2.11. LFG monitoring wells are not proposed in areas of the landfill perimeter where the slopes are so steep that the perimeter gas wells would be below the depth of fill in the Former Landfill. The perimeter gas wells will be monitored quarterly for methane to evaluate compliance with ARARs.

2.10.3 Alternative 3 - Maintenance and Revegetation of the Landfill Cover

Alternative 3 includes the institutional control components that were previously described as part of Alternative 1 and the components that were previously describes as part of Alternative 2, with this additional component:

- Remove Guinea grass from the existing cover and revegetate.

Guinea grass is currently used as the vegetative layer on the existing cover. Although Guinea grass has generally controlled erosion on the existing cap since 1983, it may be appropriate to consider other types of vegetation for an erosion layer for the following reasons:

- Guinea grass tends to have a relatively extensive root system that could damage the cap.

- Guinea grass is stalky and grows relatively tall (approximately 10 feet), making it more difficult to detect cracks or areas of subsidence on the cover during inspections and increasing the cost of cover maintenance.

Based on the considerations provided above, Alternative 3 includes removal of the existing Guinea grass using an herbicide (such as a 10 percent solution of Roundup*). An herbicide may be the only effective means of removing the existing Guinea grass from the cover. If the Guinea grass is not completely removed, it would be difficult for another type of vegetation to establish itself on the cover, given the invasive nature and extensive root system of Guinea grass.

Use of Roundup* as part of the revegetation program is not expected to cause human or environmental health concerns. Glyphosate, the common chemical name for Roundup*, has low toxicity to humans and is classified as Group E (evidence of noncarcinogenicity in humans). Glyphosate is poorly absorbed dermally. Inhalation toxicity studies were not required during reregistration procedures by EPA because of its nonvolatility. Glyphosate adsorbs strongly to soil and is expected to be immobile in soil. Glyphosate is only slightly toxic to nontoxic to birds, fish, aquatic invertebrates, and mammals.

Exposure to workers and applicators is not expected to be of concern because of glyphosate's low toxicity. Splashing of product can, however, cause skin and eye irritation. Manufacturer's recommendation for personal protective equipment must be followed to reduce the potential for exposure. Application of Roundup* should be done in accordance with the requirements of the Worker Protection Standard (40 Code of Federal Regulations [CFR] 170) (EPA, 1993b).

The cover may be revegetated using grasses such as a mix of Buffalo grass (buchloe dactyloides) and annual rye (lolium multiforum) grass. Buffalo grass is a turf-building warm season grass that is more drought tolerant, and insect resistant. Annual rye is an annual grass that will be used to provide temporary erosion control while the Buffalo grass comes in. Both species have shallow root systems, and provide a tight vegetative cover. Maintenance of the new vegetative cover may include (1) annual mowing and (2) annual application of an herbicide such as Roundup* for spot control, and to control reinvasion of Guinea grass around the perimeter of the landfill.

2.10.4 Alternative 4 - Maintenance and Revegetation of the Landfill Cover with Vapor Extraction

Alternative 4 includes the components that were previously described as part of Alternative 3, with the following additional component:

- Install a vapor extraction system in the vadose zone beneath the Former Landfill to remediate the area identified in Figure 2.12.

The conceptual layout of the vapor extraction system consists of three vapor extraction wells, six piezometers installed 50 feet bgs, and an equipment shed to house the vacuum blower and associated equipment The purpose of the vapor extraction system is to remove TCE from the area identified in Figure 2.12 and reduce the migration of TCE through the vadose zone and, ultimately, to the groundwater. Piezometers would be used to monitor the performance of the vapor extraction system by monitoring the vacuum at each piezometer. The conceptual locations of the three vapor extraction wells, the six piezometers, and the treatment shed are illustrated in Figure 2.13. Two of the three proposed vapor extraction wells would require installation and the other one is an existing vapor extraction well, VX-3. In addition, three of the six piezomaters would require installation and the other three are existing piezometers, PZ-3, PZ-5, and PZ-9. The existing vapor extraction well and the three existing piezometers were installed during the in situ air permeability tests conducted as part of the Phase II RI.

It is estimated that a maximum of 170 pounds per year (14 gallons) of TCE vapor could be emitted from the three vapor extraction wells combined. This estimate was made using the highest TCE vapor concentration (34 ppm) measured during the in situ air permeability test conducted as part of the Phase II RI and an estimated vapor flow rate from each of the three vapor extraction wells of 10 cubic feet per minute (cfm). The air discharge limit in Hawaii is 0.1 ton per year or 200 pounds per year of each hazardous air pollutant. Based on available data, the offgas from the vapor extraction system will not require treatment before being discharged to the atmosphere. Therefore, offgas treatment is not included in this alternative.

Based on the vapor temperature from Well VX-3 during the in situ air permeability tests and the average yearly temperatures for Honolulu, Hawaii, it is estimated that approximately 1 gallon per day of liquids may form in the air-moisture separator. It has been assumed for costing purposes that the liquids from the air moisture separator will be nonhazardous. The nonhazardous liquid would be transported to the Schofield Barracks water treatment facility for disposal. However, if the chemical characterization results indicate that the liquid is hazardous and at concentrations that exceed acceptance levels for the Schofield Barracks water treatment facility, the liquid will be sent to a Resource Conservation and Recovery Act (RCRA)-approved treatment facility (i.e., incinerator) for treatment and disposal.

Operation of the system is assumed to require two operators for 10 hours per week to collect samples, perform equipment maintenance, adjust system operating conditions, and record operating data. The equipment sizing and operation and maintenance (O&M) requirements are based on the initial conditions found at the site during the RI and soil vapor extraction (SVE) pilot studies. As the vapor-phase TCE concentrations decrease over time, vapor extraction wells may be eliminated from the system.

2.11 Summary of Comparative Analysis of Alternatives

This section provides a comparison of the alternatives described in Section 2. 10 with respect to the NCP criteria. A summary of the comparative analysis of alternatives is provided in Table 2.5.

2.11.1 Overall Protection of Human Health and the Environment

Alternative 1 does not provide any additional protection of human health and the environment than or than that which currently exists. Overall protection of human health and the environment would be increased by Alternatives 2, 3, or 4. Alternatives 3 and 4, which involve revegetating the existing cover, may be more protective than Alternative 2, because revegetation of the cover may enhance evapotranspiration and reduce erosion due to surface-water runoff, thereby further reducing infiltration through the cover. Alternative 4, which involves treatment of a potential hot spot, may provide some additional protection over Alternatives 2 and 3; however, the volume of TCE that may be removed is estimated to be very small and may not significantly reduce contaminant transport to groundwater.

2.11.2 Compliance with ARARs

Alternative 1 would not comply with action-specific ARARs because no further action would be performed at the Former Landfill. Alternatives 2, 3, and 4 will be in compliance with ARARs because each of these alternatives include maintaining the landfill cover, implementing groundwater and LFG monitoring programs, and implementing institutional controls.

2.11.3 Long-term Effectiveness and Permanence

Alternative 1 would not provide any additional risk reduction over the long term. Alternatives 2, 3, and 4 provide an increase in long-term effectiveness and permanence by improving the existing cap and implementing long-term maintenance and groundwater monitoring programs. The effectiveness of Alternatives 2 and 3 can be assessed by periodic landfill cover inspections, perimeter gas monitoring, and long-term groundwater monitoring. Alternative 4, which involves treatment of a potential hot spot, may provide some additional long-term effectiveness over Alternatives 2 and 3; however, the volume of TCE that may be removed is estimated to be very small and may not significantly reduce contaminant transport to groundwater. Therefore, the effectivenes of TCE removal may be difficult to assess. There will be no risk from residuals remaining at the conclusion of remedial activities for Alternatives 2, 3, and 4 because there are no complete exposure pathways as discussed in the Final OU 4 FS and the landfill cover will be maintained indefinitely.

2.11.4 Reduction In Toxicity, Mobility, and Volume

Alternative 1 does not provide any reduction in toxicity, mobility, or volume. Alternatives 2, 3, and 4 provide a reduction in mobility by improving the existing cap and providing long-term maintenance of the cap. Alternatives 3 and 4 may reduce mobility more than Alternative 2 because a different vegetative cover may enhance evapotranspiration and reduce surface erosion, thereby further reducing groundwater infiltration through the cover.

Alternative 4, which involves remediation of a potential hot spot, also provides a reduction in toxicity and volume. It is estimated that Alternative 4 may remove between 2 and 14 gallons of TCE per year using vapor extraction.

2.11.5 Short-term Effectiveness

The short-term conditions at the site would remain unchanged under Alternative 1 because no action would be implemented. Alternatives 2, 3, and 4 may have short-term impacts associated with improvements to the existing cap. Alternatives 3 and 4 also involve revegetation of the landfill cover, which involves short-term impacts associated with the application of an herbicide to the existing Guinea grass. Alternative 4 involves drilling through the landfill contents, which includes risks associated with potential exposure to VOCs and UXO. Because a relatively low volume of TCE may be removed from the potential hot spot, risks associated with drilling through the landfill contents may not be justified.

2.11.6 Implementability

Alternatives 2, 3, and 4 are considered to be implementable with minimal difficulty because they require only conventional equipment to maintain the landfill cover. Alternative 4 is more difficult to implement than Alternatives 2 and 3 because it requires intrusive work in an area that may contain unexploded ordnance and because of an increased danger of subsurface landfill fires resulting from increased subsurface oxygen levels that may occur during vapor extraction. Alternative 1 is not considered to be administratively implementable. Implementation of the selected alternative will be coordinated with EPA and DOH.

2.11.7 Cost

The net present worth of Alternatives 1 through 4 ranges between $1,100,000 (Alternative 1 - No Further Action Institutional Controls) and $8,200,000 (Alternative 4 - Maintenance and Revegetation of the Landfill Cover with Vapor Extraction). Alternative 2 (Maintenance of the Landfill Cover) and Alternative 3 (Maintenance and Revegetation of the Landfill Cover) both have a net present worth of $6,800,000. A breakdown of capital cost, O&M cost and net present worth for each alternative is presented in Table 2.6

2.11.8 State Acceptance

As indicated by DOH approval of the Final OU 4 FS and Proposed Plan, Alternative 3 is more acceptable to the state than Alternatives 1, 2, and 4.

2.11.9 Community Acceptance

Community acceptance is documented in Section 3.0 (Responsiveness Summary).

2.12 Selected Remedy

Based on consideration of the requirements of CERCLA, the detailed analysis of alternatives, and written public comment, the Army, EPA, and the State of Hawaii have determined that Alternative 3 (Maintenance and Revegetation of the Existing Landfill Cover) is the preferred alternative for Schofield Barracks OU 4. The comparative analysis of alternatives indicates that Alternative 3 is superior to Alternatives 1 and 2 with respect to protection of human health and the environment and reduction of mobility. The short-term risks associated with implementaton of Alternative 3 are slightly higher than for Alternatives 1 and 2 because Alternative 3 involves application of an herbicide. However, the long-term benefits associated with Alternative 3 include improving the integrity of the cover, facilitating quarterly inspections of the cover, and further reducing the potential for surface-water infiltration, thereby potentially reducing contaminant transport to groundwater.

Although Alternative 4 provides reduction of toxicity and volume where Alternative 3 does not, Alternative 4 was not selected as the preferred alternative because Alternative 4 involves risks associated with potential exposure to VOCs and UXO. Also, preliminary estimates indicate that only a minimal volume of contaminants (2 to 14 gallons of TCE) may be removed from the vapor extraction system on an annual basis. Therefore, the additional cost and lower short-term effectiveness for Alternative 4 may not be justified.

State acceptance of the selected remedy is indicated by DOH approval of the Final OU 4 FS. As documented in Section 3.0, no public comments were received during the public comment period for the OU 4 Proposed Plan indicating community acceptance.

Alternative 3 was previously described in Section 2.10.3. It should be noted that some changes may be made to the remedy during the detailed design and construction phase. The major costs associated with this alternative are presented in Table 2.7.

2.13 Statutory Determinations

Under its legal authorities, EPA's primary responsibility at Federal Facility NPL sites is to oversee response actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected response action for this site must comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws unless a statutory waiver is justified. The selected remedy also must be cost effective and utilize permanent solutions and alternative treatment technologies or resource reoovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy protects human health and the environment by limiting direct contact with the Former Landfill contents and by restricting surface-water infiltration through the landfill. The current and future risks associated with OU 4 in its current condition are within the acceptable range. By improving the Former Landfill cover, the already acceptable risks will be further reduced. There are no short-term threats associated with the remedy that cannot be readily controlled.

Compliance with ARARs

The selected remedy will comply with all action-specific ARARs. As documented in the ARARs analysis in the Final OU 4 FS as approved by EPA and DOH, there are no chemical-specific or location-specific ARARs. The ARARs are presented below:

- Action-specific ARARs:
  - Fugitive dust emission limitations contained in HAR 11-60.1-33(a)(1-7)(b).
  - HAR 11-55-34.02, Appendices A and C, requiring a National Pollutant Discharge Elimination System (NPDES) permit and monitoring for storm-water runoff associated with construction activity.
  - HAR 11-58.1-17(a)(9)(A, B), which requires a notation be MSWLF to indicate the land was used as a landfill.
  - HAR 11-58.1-16, requirements for groundwater monitoring during the postclosure care period at MSWLF units.
  - HAR 11-58.1-17(b) requiring postclosure care of the landfill for 30 years.
  - HAR 11-59-4(f) and (h) limiting the emission of ozone to 100 micrograms per cubic meter (mg/m3) in one hour.
  - HAR 11-60.1-68 requiring monitoring and measurement of VOC emissions if emissions are greater than 1 ton per year for each air pollutant.
- Chemical-specific ARARs
  - None.
- Location-specific ARARs
  - None.

Cost Effectiveness

The selected remedy is cost effective because it has been determined to provide overall effectiveness proportional to its costs. The estimated costs of the selected remedy are approximately equal to the costs for Alternative 2, but the selected remedy has a better long-term effectiveness. The estimated cost of the selected remedy is also less than Alternative 4 and provides a better effectiveness proportional to its cost. The additional cost of Alternative 4 to remove approximately 2 to 14 gallons per year of TCE is not deemed to be cost effective.

Utilization of Permanent Solutions and Alternative Technologies to the Maximum Extent Practicable

EPA and the State of Hawaii have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for source control of OU 4. The selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility. or volume; short-term effectiveness; and cost.

Although Alternative 4 provides greater reduction of toxicity and volume using treatment, Alternative 4 involves short-term risks associated with potential exposure to VOCS and UXO. In addition, only a minimal volume of contaminants would be addressed, therefore, additional cost is not justified. The selected remedy addresses the principal threats posed by the landfill effectively and cost effectively.

Preference for Treatment as a Principal Element

The selected remedy does not include a treatment technology, however, treatment is not deemed to be practicable. The principal threats posed by the site are direct contact with the Former Landfill contents and migration of VOCs to the groundwater. The selected remedy adequately addresses these threats by upgrading and maintaining the cover, and the OU 2 (contaminated groundwater) remedy will further address the groundwater plume. The remedy is consistent with EPA's Presumptive Remedy for Municipal Landfill Sites (EPA, 1993a) which does not require treatment.

Table 2.1: Chemicals of Potential Concern for OU 4

Media/Chemical
Surface soil
Arsenic
Beryllium
Chromium
Manganese
Sediment
Arsenic
Beryllium
Chromium
Manganese
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Dibenzo(a,h)anthracene
Indeno(1,2,3-c,d)pyrene
Surface Water
Manganese
Nitramine/tetryl

Table 2.2: Summary of Total and Incremental Risks at OU 4 for Potentially Exposed Populations

	Carcinogenic Risk		Noncarcinogenic Hazard Index	
	Total	Incremental*	Total	Incremental*
Remedial worker	1.58E-06	2.50E-07	2.96E-01	1.00E-01
Recreational user	1.30E-06	3.00E-07	8.81E-02	3.91E-02
Military personnel	7.79E-07	1.43E-07	7.57E-02	2.90E-02

Only the reasonable maximum exposure values are presented.

* Risks associated with naturally occurring levels of background inorganics have been subtracted from the total risk estimates. The incremental risks are more representative of site-related conditions than are the total risk estimates.

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<IMG SRC 0996155I>

Table 2.4 Target Compound List for Volatile Organic Compounds and Target Detection Levels for Water Sample Analyses

CAS No.	Target Compounds	Target Detection Levels (?g/l)
74-87-3	Chloromethane	2
74-83-9	Bromomethane	7
75-01-4	Vinyl chloride	1
75-00-3	Chloroethane	10
75-09-2	Methylene chloride	3
67-64-1	Acetone	10
75-15-0	Carbon disulfide	10
75-35-4	1,1-Dichloroethene	5
75-35-3	1,1-Dichloroethane	10
156-60-5	1,2-Dichloroethene (reported as the sum of cis and trans)	10
67-66-3	Chloroform	10
107-06-2	1,2-Dichlomethane	3
73-93-3	2-Butanone	10
71-55-6	1,1,1-Trichloroethane	10
56-23-5	Carbon tetrachloride	3
75-27-4	Bromodichloromethane	10
78-87-5	1,2-Dichloropropane	3
10061-02-6	trans- 1,3-Dichloropropene	10
79-01-6	Trichloroethene	3
71-43-2	Benzene	3
124-48-1	Dibromochloromethane	10
79-00-5	1,1,2-Trichloroethane	2
10061-01-5	cis-1,3-Dichloropropene	10
75-25-2	Bromoform	10
591-78-6	2-Hexanone	10
127-18-4	Tetrachloroethene	3
79-34-5	1,1,2,2-Tetrachloroethane	10
108-88-3	Toluene	10
108-90-7	Chlorobenzene	10
100-41-4	Ethylbenzene	10
108-10-1	4-Methyl-2-pentanone	10
108-42-5	Styrene	10
1330-20-7	Total xylenes	10

CAS Chemical Abstracts Service
ug/l Micrograms per liter

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Table 2.6 Estimated Capital Cost, Operation and Maintenance Cost, and Net Present Worth

Alternative	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($)	Net Present Worth ($)
1	0	70,000	1,100,000
2	2,800,000	260,000	6,800,000
3	3,400,000	220,000	6,800,000
4	3,700,000	290,000	8,200,000

O&M Operation and maintenance

* Net present worth calculated using a 5 percent discount rate and a 30-year planning horizon.

Table 2.7 Estimated Cost Summary of Selected Remedy Regrade and Revegetate Landfill Cover

Capital Cost	
Direct Capital Cost	
Regarde and Revegetate Landfill Cover	$2,034,000
Landfill Improvements	$25,000
Landfill Gas Monitoring Probes and Passive Gas Venting System	$ 51,000
Subtotal - Estimated Direct Capital Cost	$2,110,000
Indirect Capital Cost	
Contingency (30 percent)	$633,000
Engineering and Design (10 percent)	$211,000
Contractor Overhead and Profit (10 percent)	$211,000
Construction Management (10 percent)	$ 211,000
Total - Estimated Capital Cost	$3,400,000
Annual O&M Cost	
Institutional Controls	$5,000
Groundwater Monitoring	$46,600
Cap Maintenance	$87,500
Landfill Gas Monitoring and Venting	$ 30,000
Subtotal - Estimated O&M Cost	$169,000
Contingency (30 percent)	$51,000
Total - Estimated Annual O&M Cost	$220,000

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3.0 RESPONSIVENESS SUMMARY

3.1 Overview

This section provides a summary of the public comments and concerns regarding the OU 4 Proposed Plan at Schofield Barracks, Island of Oahu, Hawaii. At the time of the public review period, the Army had selected Alternative 3, Maintenance and Revegetaton of the Landfill Cover, as the preferred alternative for the OU 4 Former Landfill. Verbal comments were received and addressed during the public meeting. On the basis of the lark of written comments received, the Army's Proposed Plan was generally accepted by the public.

3.2 Background on Community Involvement

The Army has implemented a progressive public relations and involvement program for environmental activities at Schofield Barracks. A Technical Review Committee, comprised of representatives from the Army, the EPA, the State of Hawaii DOH, and members of the general public, has been established and meets periodically to involve the public in decisions made regarding investigation results, proposed work, and potential remedial actions. The Army distributed over 50 copies of a fact sheet to interested parties and to the information repositories (Section 2.6). These fact sheets described the installation restoration program at Schofield Barracks, including a discussion of how the public could get more information and get involved in the program. A synopsis of community relations activities conducted by the Army is presented in Appendix A.

The Army held a public comment period on the alternatives presented in the OU 4 FS and Proposed Plan from April 11 through May 11, 1996. Over 100 copies of the Proposed Plan were mailed to the public for review and comment and were placed in the repositories discussed in Section 2.6. The Proposed Plan also invited readers to a public meeting to discuss the preferred alternative. The meeting was held on May 1, 1996, at 7:00 p.m. in the Hale Koa at Wahiawai District Park, 1139 A Kilani Avenue, Wahiawa, Hawaii.

No written comments were received from the public regarding the OU 4 Proposed Plan during public comment period.

3.3 Summary of Comments Received During Public Comment Period and Department of the Army Responses

No written comments were received from the public regarding the OU 4 Proposed Plan.

4.0 ACRONYMS

1,1,1-TCA	1,1,1-Trichloroethane
1,2-DCE	1,2-Dichloroethene
ARAR	Applicable or relevant and appropriate requirement
Army	U.S. Department of the Army
B=	Benzene, toluene, ethylene, and xylenes
bgs	Below ground surface
BWS	Board of Water Supply
CCL4	Carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Chn	Cubic feet per minute
CFR	Code of Federal Regulations
COPC	Chemical of potential concern
DERP	Defense Environmental Restoration Program
DOD	U.S. Department of Defense
DOH	Department of Health
EIA	Environmental impact Assessment
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
EP TOX	Extraction procedure toxicity test
ERA	Ecological risk assessment
ESE	Environmental Science and Engineering
FFA	Federal Facility Agreement
FS	Feasibility study
GMW	Gas monitoring well
HAR	Hawaii Administrative Rules
HLA	Harding Lawson Associates
HRA	Health Risk Assessment
IRP	Installation Restoration Program
LFG	Landfill gas
MCL	Maximum contaminant level
mm	Millimeter
MSL	Mean sea level
MSWLF	Municipal Solid Waste Landfill
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGVD	National Geodetic Vertical Datum of 1929
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operations and maintenance
OU	Operable unit
PA/SI	Preliminary assessment/site investigation
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
ppbv	Parts per billion volume
ppm	Parts per million
PRG	Preliminary remediation goal
RBSC	Risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
RME	Reasonable maximum exposure
RMT	R.M. Towill Corporation
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
Schofield Barracks	Schofield Army Barracks
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
TAMC	Tripler Army Medical Center
TCE	Trichloroethene
TEPS	Total Environmental Program Support
TVH	Total volatile hydrocarbons

USAEC	U.S. Army Environmental Center
USAPEHEA	U.S. Army Pacific Environmental Health Engineering Agency
USASCH	U.S. Air Support Command Hawaii
UXO	Unexploded ordnance
VC	Vinyl chloride
VOC	Volatile organic compound
WWII	World War II
mg/l	Micrograms per liter
mg/m3	Micrograms per cubic meter

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Appendix A

SYNOPSIS OF COMMUNITY RELATIONS ACTIVITIES

May 1985 - Schofield Barracks issued a press release regarding the detection of Trichloroethylene (TCE) in the Schofield Barracks Supply wells and the temporary switch to city and county water supplies.

August 1990 - Schofield Barracks issued a press release regarding the placement of the installation on the National Priorities List (NPL).

October 1990 - Schofield Barracks Public Affairs Office and Environmental Office addressed the Wahiawa Neighborhood Board regarding Army plans to conduct investigations on Schofield Barracks to identify sources of TCE.

January 1992 - Schofield Barracks and U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) submitted press releases requesting public involvement in locating the source(s) of TCE contamination in and around Schofield Barracks.

January 1992 - Schofield Barracks and USATHAMA conducted interviews with twenty local residents to assist in the development of a Community Relations Plan for the Schofield Barracks Installation Restoration Program (IRP).

June 1992 - The Army finalized the Community Relations Plan for Schofield Barracks and placed copies in the newly established information repositories located in the Military Public library, the Wahiawa Public Library, The Hawaii Department of Health, and the Directorate of Public Works in Building 300 of Wheeler Army Airfield.

February 25, 1993 - Schofield Barracks and the Army Environmental Center (AEC) conducted a public meeting at the Hale Koa at Wahiawa District Park in Wahiawa to provide the public with an update on the IRP and the results of the first phase of the investigations.

February 1993 - In conjunction with the public meeting, the Army published and distributed a fact sheet that provided an update on the IRP and initial investigative results.

September 13 and 14, 1994 - Schofield Barracks and the AEC conducted public availability sessions at the Hale Koa at Wahiawa District Park (September 13) and at the Schofield Barracks Post Library (September 14) to provide an update on the IRP.

September 13 and 14, 1994 - In conjunction with the public availability sessions, the Amy solicited interest in the formation of a Restoration Advisory Board(RAB) comprised of local citizen representatives, Army representatives, and regulatory agency representatives that would oversee the conduct of the Armys IRP at Schofield Barracks.

September 12 through 14, 1994 - The Army presented a poster display that summarized installation restoration efforts and Plans for Schofield Barracks at the 1st Hawaii National Technologies Conference sponsored by the Hawaii Department of Health

September 1994 - In conjunction with the public availability session, the Army published and distributed a fact sheet that provided an update on the IRP and initial investigative results.

April 11 through May 11, 1996 - Schofield Barracks conducted a public review period for the Proposed Plan for Operable Unit 4.

May 1, 1996 - Schofield Barracks and the AEC conducted a public meeting to present the Operable Unit 4 Proposed Plan and solicit public comments.